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ABSTRACT

This paper reports on research to study the benefit of a punctual self-directed learning experience with a hypermedia in the appropriation of a foreign language. Twenty-eight educational sciences students took a 55 item pretest on English notions. The students then engaged in a self-directed learning session using the CD-ROM, "L'anglais d'aujourd'hui en 90 lecons," (a "Studio Multimedia" product) and later took a post-test consisting of the same 55 questions as the pretest. Results are discussed in the following areas: (1) the concept of "spectrum of performances," i.e., the distribution of a student's answers according to their type along a spectrum from incorrect with a high degree of confidence to correct with a high degree of confidence; (2) the notion of "ideal spectral evolution"; (3) quantification of the four hemispectrum shapes; and (4) categorization of individual cases as outnorming students, ideal students, stationary students, radicalized students, weak students aware of their progresses, and students unaware of their progresses. Figures and tables illustrate: confidence degrees; states of partial knowledge; ideal spectral evolution; expected spectral evolution; skewness coefficients; and one student's spectrum of performances, performances card, and realism graphs. Contains 22 references. (DLS)

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Self-Directed Learning of University Students Using a Hypermedia on English: Spectral Analysis of Their Performances

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Abstract: Today we are witnessing an explosion of the learning resources on the one hand and on the other hand a need of continuous learning [Leclercq & Denis 95]. In this context autonomous learning will take an increasing part of the educational process and people will turn more and more towards computerised products. As educationists, we study how and what people learn by exploring these resources... to be able afterwards to offer them helps to improve their learning strategies... and outcomes.
For one year, we have been conducting a research on learning strategies with a CD-Rom on English. Our research has been attempting to study the benefit of a punctual self-directed learning experience with a hypermedia in the appropriation of a foreign language. Our two main research questions are : (1) What is the evolution of each student's "spectrum of performances" between the pretest and the post-test ? (2) Which learning strategy does he/she use and what is his/her efficiency ?

Context

In the current context of self-directed learning, people turn more and more towards computerised products... The Task force's report on Multimedia Educational Software edited by the European Commission (1996) shows for example the predicted evolution of CD-Rom drives in families between 1994 and 1998 (for Europe, 2.74 millions in 1994 and 35.96 millions in 1998).
We start from the idea that a lot of commercial tools do exist on the market and are actually used. As educationists we have no control on their diffusion but we can turn the situation to best account and formulate recommendations concerning their use. That is why we study how and what people learn by exploring these computerised informational resources... to be able afterwards to offer them helps to improve their learning strategies... and outcomes.

Research Object and Questions

For one year, we have been conducting a research on learning strategies exhibited by students using a hypermedia on English (as a Foreign Language). Our main research question is : " What is the benefit of a *punctual self-directed learning experience* with a hypermedia in the appropriation of a foreign language ? ". More precisely, we attempt to answer the two following questions : (1) What is the evolution of each student's " spectrum of performances " (see [Concept of " Spectrum of Performances "]) between the pretest and the post-test ? (2) Which learning strategy does he/she use and what is his/her efficiency ?

Progress of the Experiment

Pretest

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Our main objective is to measure the impact of self-directed learning by exploring three English lessons in the CD-Rom " L'anglais d'aujourd'hui en 90 leçons " (a " Studio Multimédia " product). Therefore, last year, 28 students registered in the first year of the licence in Educational Sciences received a pretest containing 55 items (short open-ended questions) on English notions. These notions represent 55 " opportunities to learn " (OTL) precisely located in the hypermedia lessons. Students had to complete the test and accompany each of their answers with one of the six following " confidence degrees ".

Interval of the probability axis	*0-25*	*25-50*	*50-70*	*70-85*	*85-95*	*95-100*
Codes for confidence degrees	0	1	2	3	4	5

Figure 1: confidence degrees

The reasons for this (asymmetric) segmentation of the probability axis have been explained elsewhere [Leclercq 83 & 93] and are related to what is currently known of the human capacity in discriminating different levels of doubt (or partial knowledge).

Self-Directed Learning Session

At the beginning of the self-directed learning session, students received directions for navigation and got familiar with the possibilities of the hypermedia. Later, students explored individually three lessons of the hypermedia (n° 25, 35 and 40) during one hour as a maximum. Half of the students received back their pretest during the self-directed learning session with a short feed-back on their answers (correct answer incorrect answer) ; the other half did not receive anything. This experimental design aims to compare learning strategies of students with " objective learning needs " and learning strategies of students with " subjective learning needs ". The first situation is similar to school situation ; the second one to everyday life.

After the self-directed learning session, students were given a self-assessment questionnaire on their degree of appreciation of the self-directed learning session ; on their initial objectives ; on their learning strategies ; on their feeling to have learned something ; on their computer literacy ; on their practical experience in self-directed learning ...
All the learner's actions in using the hypermediated lessons were video-taped with the help of a " Maxi Converter Pro " system, a hardware converter that allows to display the computer screen on a television screen and or to record the tracks on a video cassette.

Post-test

Students received the same 55 questions as in the pretest. The post-test was not given immediately after learning, but postponed, since students have not had the learning session at the same time and because we prefer to measure long-term effects of self-directed learning.

Analysis of the Results

Concept of " Spectrum of Performances "

Too often the answer to a question is considered in a binary way : it is correct or incorrect without any concern for the learner's conviction [Gilles 96]. Nevertheless, pioneers like [De Finetti 65], [Van Naerssen 66], [Shuford *et al.* 66], followed by a lot of researchers [Bruno 93], [Dirkzwager 93], [Fabre 93], [Gilles 96], [Hunt, 93], [Jans 95], [Jans & Leclercq 97], Leclercq 83 & 93], [Plunus 96], [Van Lenthe 93] recommend that researchers deal with different states of partial knoweldge to study learning.

The expression of doubts with the system of confidence degrees enables to take account of these different states. [Plunus 96] and [Leclercq, Gilles & Jans 97] defined 6 of them, represented in a "spectrum of performances" :

	Incorrect answers ...						omit	Correct answers ...					
... with Confidence Degree ...	5	4	3	2	1	0		0	1	2	3	4	5
Central value of confidence zone	98	90	78	60	38	13		13	38	60	78	90	98
Unknown ignorance	X	X											
Simple ignorance			X	X									
Admitted ignorance					X	X							
Unknown knowledge								X	X				
Simple knowledge										X	X		
Perfect knowledge												X	X

Figure 2: 6 states of partial knowledge

The student's " spectrum of performances " can be defined as *the distribution of his answers according to their type* : from incorrect answers with a high confidence degree (the worst or leftmost part of the spectrum) to correct answers with a high confidence degree (the best or rightmost part of the spectrum), passing through errors with doubt and correct answers with doubt (intermediate states).

Notion of " Ideal Spectral Evolution "

A spectral analysis for a test will be called " static spectral analysis " when it concerns a fixed state. A " bi-static spectral analysis " compares two states (two spectra), for example a pretest and a post-test, i.e. the global evolution of the performance, but not question after question (that is the object of the dynamic analysis).
In our experiment, two spectra for each student are drawn : the first is related to his/her pretest performances ; the second one concerns his/her post-test performances, so that bi-static spectral analysis will be possible.
[Fig. 3] illustrates the kind of " couple of spectra " (pretest and post-test) ideally expected :

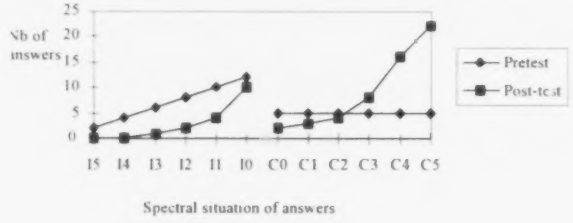

Figure 3: example of "ideal spectral evolution"

The following observations are expected :

	Incorrect Answers	Correct answers
PRE	No matter what the content is, they should always be accompanied by a low confidence degree (CD)	No special expectation. According to the test content (easy or difficult for the student), he/she will know a bit or more partially, with CD between 0 and 5. In our example, they are distributed uniformly.
POST (similar to the pretest)	Their number should decrease, mainly answers with a high CD. The curve should present an escarpment more pronounced on the right (J-shaped curve).	They should be more numerous and more confident. They should also present a J-shaped curve.

	The escarpment increase is mainly due to a *realism* increase.	The escarpment increase is mainly due to a *competence* increase.

Table 4: expected spectral evolution

Quantification of the Four Hemispectrum Shapes

The escarpment or steepness of the two " curves " (strictly, histograms should replace the curves ; we decided to join the tops of histograms in order to facilitate the comparison between pretest and post-test) can be quantified [Laveault & Grégoire 97] with the asymmetry coefficient (*skewness*). This mathematical function characterizes the asymmetrical degree of a distribution according to the mean. A *positive* asymmetry means a distribution with its "tail" moved forward the right side of the graph (i-shaped curve). A *negative* asymmetry means a distribution with its "tail" moved forward the left side of the graph (j-shaped curve).

The *skewness* index equation is : $$\frac{n}{(n-1)(n-2)} \sum \left(\frac{x_i - \bar{x}}{s} \right)^3$$

Here are the skewness coefficients computed for the four curves of our example. If the series of intervals of our six confidence degrees were symetrical, the skewness of the right side pretest curve would have been 0.

	Incorrect answers (left side)	Correct answers (right side)
Prétest	*-0.49*	*-0.14*
Post-test	*-2.03*	*-1.15*

Table 5: skewness coefficients

Categorization of Individual Cases

Our first experimentation led us to distinguish 6 types of students according to their "spectrum of performances" and their "performances card", i.e. their pre- and post-test results, their (absolute and relative) gains, their indices and graphs of realism, their skewness indices : (1) *outnorming students* (overcompetent or undercompetent) ; (2) *ideal students, aware of their (important) progresses* ; (3) *stationary students* ; (4) *radicalized students (at post-test)* ; (5) *weak students, aware of their progresses* ; (6) *students unaware of their progresses.*

Different clues can help to explain the evolution of the "spectrum of performances". They are related to : (1) the subject's learning strategy (duration of the exploration ; lessons really explored ; consulted screens ; number of "seized" opportunities of learning ...) ; (2) the learner him/herself (his/her initial competency ; his/her objectives ; his/her motivation to explore the hypermedia ; his/her computer and hypermedia literacy ; his/her satisfaction after the learning phase ...) ; (3) the learner's knowledge of pretest performance (objective feedback or subjective impression ?).
Detailed results are analysed in a previous article [Jans 97]. This paper presents only one example, Student 11, an "ideal" student, with his realism indices and his realism graphs.

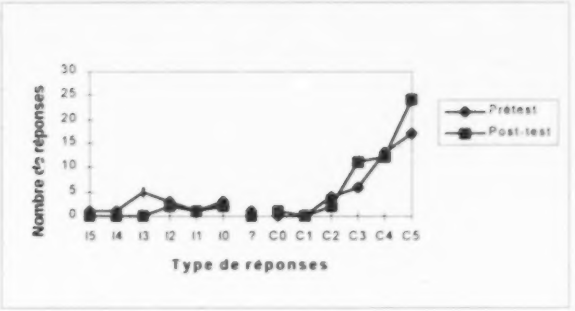

Figure 6: Student 11's "spectrum of performances"

Score (PRE) : 38,61 %	Realism (PRE) : 0.9 (very good)
Score (POST) : 60,32 %	Realism (POST) : 0.88 (very good)
Absolute gain : 21,71 %	Skewn. (PRE) : Incorr. A. : 0,73 Corr. A. : -1,42
Relative gain : 36,87 %	Skewn. (POST) : Incorr. A. : 0,05 Corr. A. : -3,1

Table 7: Student 11's "performances card"

Realism (pretest) **Realism (post-test)**

Figure 8: Student 11's "realism graphs"

We defined an « ideal student » as *a student who makes progress in the two expected levels* :

(1) *in his knowledge of English* : The curve of his post-test "goes up" towards the right (peak at C5). His relative gain is high (37%).
(2) *in realism* : In this case, St.11 does not increase his realism index at the post-test, but this index was already "very good" at the pretest, refering to [Gilles 96] norms.

Interviewed, St. 11 declared he appreciated the self-directed learning session. The English level suited him very well. He did not have the opportunity to consult his pretest before the learning session. Nevertheless, his process of navigation in the CD-Rom was efficient, seeing that the rate (55%) of his "seized opportunities to learn" is higher than the mean of the group's rate (45%).

Conclusions

There does not exist something such as "the only one good way to explore a hypermedia". Moreover, students are characterised by what [Denis & Leclercq 94] called " mathetical ambivalence ", i.e. the need to rapidly

change from an autonomous learning situation (let me try, let me search, let me create) to a dependent situation (tell me, show me, correct me) and vice versa. The hypermedia " L'anglais d'aujourd'hui en 90 leçons " allows these reversible shifts.

One kind of problems encountered by a hypermedia user concerns the navigation in the great mass of information. In collaboration with the CNRS - IRPEACS of Lyon, we are developing and experiencing new tools to facilitate the navigation in a hypertext [Zeiliger *et al.* 96 & 97].

The analysis of the first results stressed interesting recommendations to carry on with the research into this field. The second part of our research project will aim to compare the impact of self-directed learning on the one hand and of collaborative learning in the other hand of university students navigating in hypermedia. That's why, this year, 30 students were asked to experiment the two situations in English learning. Different indices such as the evolution of their " spectrum of performances ", their (absolute and relative) gains on competencies, their satisfaction,... will be analysed and compared according to the two experimental conditions.

It is hoped that from this research recommendations could be drawn about learning with hypermedia to attain objectives that the learner (or the learners' group) has assigned to himself.

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